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Investigation on the electron flux to the wall in the VENUS ion source

Thomas Thuillier[1], Julien Angot[1], J. Y. Benitez[2], A. Hodgkinson[2], C. M. Lyneis[2], D. S. Todd[2], D. Z. Xie[2]

[1] *LPSC, Université Grenoble-Alpes, CNRS/IN2P3, 53 rue des martyrs 38026 Grenoble cedex, France*
[2] *Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*

Corresponding Author: Thomas Thuillier, e-mail address: thuillier@lpsc.in2p3.fr

The long-term operation of high charge state electron cyclotron resonance ion sources fed with high microwave power has caused damage to the plasma chamber wall in several laboratories. Porosity, or a small hole, can be progressively created in the wall on a year time scale, which can cause a water leak from the cooling system into the plasma chamber vacuum. A burnout of the VENUS chamber is investigated. Information on the hole formation and on the necessary local hot electron power density is presented. Next, the hot electron flux to the wall is studied by means of simulations. First, the results of a simple model assuming that electrons are fully magnetized and strictly following magnetic field lines are presented. The model qualitatively reproduces the traces left by the plasma on the wall and shows characteristic sub-patterns, which are seen experimentally. However, it is too crude to reproduce localized power densities of the electrons at the wall necessary to make a hole in the chamber wall. Second, the results of a Monte-Carlo simulation following a population of hot electrons into the ion source is presented. The simulation includes electron scattering. This time, a localized, high power density deposition to the wall results. A comparison between simulation and experiment is discussed in the case of the VENUS source. Finally, options to avoid hole formation in ECR ion sources chamber walls are explored.